STANDARD OPERATING PROCEDURE

TITLE: OPERATION OF THE K-31 LUBE OIL SYSTEM

INTRODUCTION

Each unit in K-31 is provided with its own lubricating system to maintain a continuous supply of clean oil to the bearings of the stage and booster station compressors and their respective motors. Each system consists of an elevated supply tank located between the roof trusses, a supply piping system, a return piping system, drain tank, auxiliary drain tank, pumps, filter, and cooler. Each system contains approximately 12,000 gallons of oil, all of which can be contained in the two drain tanks. Under normal conditions there are approximately 6,750 gallons of oil in the supply tank, 3,200 gallons in the drain tank, and 2,000 gallons in the system lines between the tanks. The supply tank supply and drain valves are motor operated (MOV's) with controls and indicating lights in the Area Control Room (ACR). A normal and emergency power supply is provided for operation of the MOV's.

At each booster station the design is such that the lube oil can be supplied from either of the adjacent units. The purge and evacuation station lube oil supply and return lines are connected to the respective lines on the Unit 3 system at Cell 1 and Unit 4 at Cell 1. Oil is also supplied to the pumps in the seal exhaust stations, the wet air station, and datum stations. Since the oil in these pumps must be replaced frequently, this oil is not recirculated.

A diagram of the K-31 unit lube oil system is presented in Figure 1.

DESCRIPTION

In each unit, oil from the drain tank is piped to one of two centrifugal pumps, each with a capacity of 500 gallons per minute against a 110-foot head. Either of these pumps is capable of delivering an adequate supply of oil to the unit, the other being used as a spare. The spare pump when set on automatic control should start whenever the level in the supply tank drops below the set point on the level buoy. This set point coincides with the level in the supply tank at which there is no overflow from the supply tank weir to the drain tank. At this point a low level alarm on the unit panel in the ACR is actuated. If the breaker to the pump which is running has tripped, a light on the unit panel in the ACR will indicate that the breaker is open; however, the spare pump will not start until the level in the supply tank drops below the set point on the level buoy controller.

The pump which is running discharges into a double basket type strainer which has a chain and sprocket arrangement for shifting inlet and outlet gates. This permits the cleaning of one strainer basket while flow is diverted to the other. These strainers remove all solid particles larger than .005-inch in diameter and have a maximum pressure drop of 2.5 psi across a basket for a 30% plug.

The oil supply is normally valved through a cooler which operates off the recirculating cooling water (RCW). The cooler RCW return valve is always open 100% and the supply valve is open only enough to control lube oil temperature at 120° ± 2°. The temperature can be read at each unit lube oil pit on the operating floor. The lube oil cooler is equipped with a bypass valve which can be used in an emergency by opening the bypass valve and closing the inlet and outlet valves. The capacity of the cooler is 3,000,000 BTU/hour, or the equivalent of cooling 500 gallons of oil per minute from 150°F to 120°F.

The oil is then pumped to the unit supply header which is vented to the roof at both ends, and to the elevated supply tank which functions as a vented surge drum and provides a 15-minute emergency supply in the event of a lube oil pump failure. The supply and drain tanks have individual 2-inch vent lines and a common 4-inch vent line leading through the roof. The auxiliary drain tank has a 2-inch vent line which ties into the 2-inch drain tank vent line. These vents serve to prevent any possible vacuum in the supply tank or back pressure in the drain header or drain tank. The oil in the supply header to each cell passes through an emergency cutoff valve on the operating floor. The oil flow for each cell system is regulated manually with the cell floor cutoff valve to maintain a 5 psig pressure downstream of the valve, which is the proper pressure for correct supply to the compressor bearings. Each cell supply piping is divided into four branch headers serving the four banks of process compressors and motors. Separate branches supply each motor and each end of the compressor.

Each lube system is equipped with a molecular sieve which consists of a steel container filled with a 75-pound charge of type 4A Linde molecular sieve material. A flow of oil is routed through the sieve from the discharge of the operating lube pump and is returned through a purolator-type filter to the top of the auxiliary lube supply tank. Screens are installed in the inlet and outlet of the molecular sieve bed to contain the pellets to the sieve.

The function of the molecular sieve is to remove the moisture and varnish from the oil. The interfacial tension (IFT) of the oil is maintained above 20 dynes/cm and the neutralization number is maintained below .15. Samples of the oil before and after the sieve are taken monthly and checked for the IFT and neutralization number. Valving is provided to allow the pellets to be replaced as needed. The frequency of pellet change-out is determined by the ΔP across the bed and the results of the oil samples.

Flow to the compressor bearings also is controlled by means of orifices at or in the bearing assemblies. The orifice for the thrust bearing supply is twice as large as the orifice for the load bearing supply. Flow to each of the motor bearings is adjusted by means of a visible drop Gits oiler. A valve on each motor supply line permits separation of the motors from the unit supply system if necessary. In the event it is necessary to close the oil supply to the motor temporarily while repairs are being made, the motor is capable of continued operation, providing there is sufficient oil in the bearing shell reservoir. It is extremely important to note, however, that the oil supply to the bearings of running compressors cannot be valved off, even for a few seconds.

The lube oil flows by gravity from each compressor and motor bearing through the branch and main return piping to the drain tank. The oil from the compressor bearings passes a flame arresting vent and through a bulls-eye sight glass before reaching the branch line of the cell return line. The flame arresting vent prevents flames from entering the return header. The vents also eliminate the possibility of a vacuum being pulled by the oil flow in the return lines. The unit return lines are pitched to insure gravity flow to the drain drum.

The overflow from the supply tank to the drain tank is through a weir box. The weir regulator is an 8.4-inch inverted V cut into one side of a 14-inch deep box that is mounted on the top of a 6-foot standpipe within the supply tank. This standpipe is the origin of the 4-inch supply tank overflow line to the drain tank. The weir is designed so the amount of oil which overflows to the drain tank is directly proportional to the height of oil above the lower edge of the weir notch.

The level in the supply tank can be read on remote level indicators located at the drain tank and in the ACR, as well as on the sight glass at the supply tank. The amount of overflow can be seen through a bulls-eye sight glass located on the top of the drain tank. In order to avoid an excess of overflow both discharge valves on the supply pumps are throttled.

The flow is controlled by the discharge valve rather than the suction valves to prevent pump surging and possible air locks. If the level in the drain drum drops below the set point on the level buoy, an audible and visible alarm is actuated on the unit panel in the ACR.

Both the supply and drain tanks are mounted within concrete diked areas. These pits would contain the oil from an oil break or spill at these locations and help to prevent unnecessary hazards encountered from such a break. The supply tank diked area has a 4-inch drain line leading from the floor to the drain tank diked area. Therefore, the oil from a spill at either location would accumulate at the drain tank, from where it could be filtered and reused.

Whenever necessary, oil can be added to a system through a charging line on the drain tank. A manifold is connected to the charging line and air pressure is used to force the oil from a supply wagon into the drain tank. It is also possible to add oil to the system through a recovery filter which is attached to the lube oil return line at the center of each unit on the cell floor. This is usually used to return small quantities of oil to the system.

PROCEDURE

1. It should be noted that the lube oil motorized supply valve is located between the pump discharge and the supply tank. Operation of a lube oil pump with this valve closed will result in the discharge of oil onto the roof. Thus the lube oil supply valve must always be 100% open any time a lube oil pump is running.
2. The motorized drain valve from the lube oil supply tank is intended to permit emergency draining of this tank. In the event of a roof fire, for instance, the supply tank should be drained as rapidly as possible after shutting down the running process equipment.
3. Lube oil flow is the lifeblood of the cascade process equipment. A normal lube oil flow is necessary for operation of all compressors and motors, and a restricted oil flow is reason for immediate shutdown.
4. Low level alarms on the unit supply tank could indicate that the pump discharge valve is throttled too much while low drain tank level could indicate that lube oil is being lost from the system through a line break or other leak.

At the beginning of each shift and more often if necessary:

1. Check all unit lube oil pumps, motors, and couplings for defects such as leaks, excessive vibration, and high temperature.
2. Check the lube oil pump discharge pressure. It should be between 22 and 25 psig. If the discharge pressure exceeds 28 psig, switch the basket filters and have the plugged filter cleaned.
3. Check the lube drain drum level. It should be approximately 30 inches and should remain relatively unchanged from shift to shift.
4. Check the supply tank level. It should be approximately 82 to 84 inches on the sight glass or from 92 to 98 divisions on the PI. The PI indicates from a fulscope mounted at the top of an 84-inch Taylor level buoy.
5. Maintain 5 psig pressure downstream of the filters on the cell supply lines with the cell supply valves on the cell floor. If the valve is wide open and 5 psig cannot be maintained, switch the cell duplex filters and clean the plugged filter.
6. Any time the oil lines have been involved in maintenance, be sure adequate flow is established through these lines before the equipment involved is started.

7. Following compressor bearing trouble, the cell and unit oil filters should be checked for any abnormal plugging conditions.
8. The entire unit system of oil lines should be checked frequently for leaks, breaks, or any condition that may cause damage to the system.
9. Following a stage motor replacement, the new motor bearing reservoir must be filled with oil before the motor is started (1 quart of oil for each bearing for all K-31 motors).

Each Sunday on the 4-12 shift, the low-level alarm on the supply tank should be checked in the following manner:

1. Close the valve to the bottom of the float chamber.
2. Slowly open the valve on the line from the float chamber to the return line, allowing the level in the chamber to drop.
3. The audible and visible low-level alarm will actuate in the ACR and the spare pump should start when the remote level indicators at the drain tank and in the ACR drop approximately 13 PI divisions. Normal levels as indicated by the PI are from 92 to 98 divisions, or 82 to 84 inches on the sight gauge.
4. As soon as the spare pump is started and is pumping oil, close the vent on the top of the pump. This vent is a permanent bleed and prevents a vapor lock when starting the spare pump.
5. Establish the normal oil level in the supply tank.
6. Place the selector switch for the pump just started on manual control.
7. Shut down the pump which had been running.
8. Open the vent line on top of the down pump.
9. Turn selector switch on down pump for automatic control. The down pump cannot be started with the manual switch if the selector switch is set for automatic control.
10. If necessary, the pump discharge valve may be varied in order to establish the correct overflow from the supply tank to the drain tank.

Drain Tank Alarm Check

Check the drain tank alarm on the first of each month as follows:

1. Close the valve on the bottom of the sight glass.
2. Place a container under the float chamber drain spout and slowly drain the oil from the chamber.
3. Observe the oil level in the sight glass when the ACR alarm is actuated. The alarm should be actuated when the level drops 0.5-inch.
4. To reset the alarm, move the red set point towards the high mark on the dial of the level buoy until the ACR alarm is energized, then back off the pointer until the alarm is deenergized.
5. When the alarm will energize at 0.5-inch below the normal level, open the valve at the bottom of the sight glass.

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